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THE ROLE OF ARMY RAILROADING AT THE TACTICAL LEVEL OF WAR

A Monograph

by

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The paper concludes that fundamental improvements in the Army railroading program are necessary. What is needed most is attention focused at the highest levels of the Army to provide central direction of transport needs, including rail. Without that, military rail will be subject to continued drifting and the target of even further reductions.

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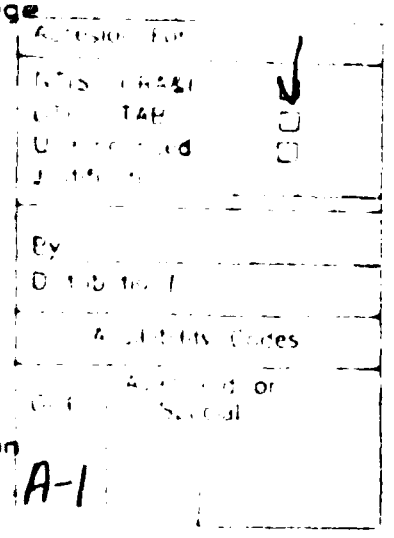

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ABSTRACT

THE ROLE OF ARMY RAILROADING AT THE TACTICAL LEVEL OF WAR, by Major Bradley E. Smith, USA, 100 pages.

Railroads have played a key role in the conduct of war for well over a century. Few can dispute the contributions rail has made at the strategic and operational levels of war. Tactical use of railroads, however, is an entirely different matter. There have been some instances of successful tactical employments of rail throughout the history of modern war but little has been written about it. Most question the modern applicability of rail in the tactical sphere and see it as an anachronism.

In certain circumstances, tactical rail might be used to deliver men, equipment and supplies into the rear of tactical units. And trains have been used as fighting platforms to provide a measure of self-defense.

Because U.S. Army rail assets have dwindled away to almost nothing, this paper examines whether tactical applications of rail warrant an increase in Army rail capabilities. Historical examples are provided, followed by the case for tactical rail and the case against it with counterarguments. Current U.S. Army rail capabilities are contrasted with anticipated tonnage shortfalls in a mid-intensity, conventional war. Implications for the future are addressed.

The paper concludes that fundamental improvements in the Army railroading program are necessary. What is needed most is attention focused at the highest levels of the Army to provide central direction of transport needs, including rail. Without that, military rail will be subject to continued drifting and the target of even further reductions.

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I. Introduction

Railroads have played a key role in the conduct of war for well over a century.[1] Few can dispute the contributions rail has made at the strategic and operational levels of war. Tactical use of railroads, however, is an entirely different matter. There have been some instances of successful tactical employments of rail throughout the history of modern war but little has been written about it. Most question the modern applicability of rail in the tactical sphere and see it as an anachronism.

Before reconsideration can be undertaken, however, several terms need defining. Rail movements across a theater of operations from seaports of debarkation (SPODs) or aerial ports of debarkation (APODs) to the combat zone is rail at the operational level of war. Rail movements across an entire continent with cargo originating at industrial/mobilization bases belonging to one of the participants is rail at the strategic level of war.

FM 100-5 defines the tactical level of war as.

> ....the art by which corps and smaller unit commanders translate potential combat power into victorious battles and engagements...Sound tactics win battles and engagements by moving forces on the battlefield to gain positional advantage over the enemy.[2]

Usually a corps is considered the senior tactical organization and normally, but not always, it operates at the tactical level. Tactical applications of rail, therefore, would usually occur within the corps boundaries.[3]

The concept of tactical rail is that, first, in certain circumstances, it might be used to deliver men, equipment and supplies into the rear areas of tactical units. That would be consistent with U.S. Army throughput doctrine. (Throughput bypasses more than one step in the supply system and minimizes the transloading of cargo.) It is worth noting that trains have been used as fighting platforms to provide a measure of self-defense. Today armored trains might enhance the survivability of trains carrying out resupply missions through areas subject to raids by enemy forces.[4]

Tactical sustainment should not be viewed in isolation from higher echelons of support. There must be interface and interdependency to form the foundation for a logistical system. Examples cited to support the concept of tactical rail will therefore involve operational rail to some extent. This makes sense, if for no other reason that trains cannot simply materialize inside the tactical realm. Nor is it realistic to assert they operate only there.

One well known operational commander took such a systemic view of logistics. He was General James Van Fleet, Commanding General of U.S. Eighth Army in Korea from 1951 to 1953. He believed that all combat commanders, regardless of their

position, had three primary concerns: mission, available combat power and transportation resources.[8] Logistical planners attempt to achieve a proper mix of transportation modes (rail, motor, inland waterway, and air) that will ultimately support the tactical plan. Strengths of each mode can be capitalized upon to generate an optimum support package.[9] It would be foolish to discount the value of a particular mode such as rail because of some preconceived notions. After all, rail for General Lee's fleet proved to be a valuable source of transport throughout the Korean war.

But now, U.S. Army rail assets have dwindled away to almost nothing. The rationale and justifications were basically ones of cost effectiveness. Because the military could rely on civilian resources overseas to do the job, it was argued, a poor return on investment would result from the cost of Army railroading.[10] Such reasoning may be flawed and logistical opportunities lost if potential uses of rail really do exist at the tactical level.

Because modern weapon systems consume more petroleum products and ammunition than ever before, tonnage requirements will be staggering in future conflicts. Implementing AirLand Battle doctrine will stretch our logistical capabilities to their limits.[11] Logisticians are obligated to come up with plans now to better support our combat forces in the future. Rail may play a role in those plans -- even at the tactical level.

So, we must examine the facts to determine whether tactical applications of rail warrant an increase in Army rail capabilities. Historical examples, the case for tactical rail and the case against it must be considered. Current U.S. Army rail capabilities must be contrasted with anticipated tonnage shortfalls in a mid-intensity, conventional war. Implications for the future can only then be addressed.

II. Historical Applications of Tactical Rail

Perhaps history can shed light on the potential uses for Army railroading in the future as well as its limitations. Rail has been used to support combat forces well forward in a theater of operations. Some highlights from previous wars illustrate the past contributions of railroads. That may help us decide if its potential for tactical operations warrants the cost of increased military rail units.

The War Between the States

In the American War Between the States, Confederate reinforcements arrived by rail during the First Battle of Bull Run in August 1861. The Manassas Gap Railroad brought them to railheads near the battlefield, where the troops detrained and marched toward the sound of the guns. General Beauregard was

able to mass these men close to the Union line and outflank the Federals.[9]

Rail again figured prominently in the Civil War at the Battle of Chickamauga in September 1863. Portions of General Longstreet's corps -- an estimated 6,000 men -- arrived at Chickamauga railheads while the fight was underway. These additional forces contributed to the Confederate victory.[10]

World War I

Rail proved critical to the French during World War I. Trains rotated heavy artillery among defensive positions at the front. Railroads became the principal means of moving fresh troops and supplies forward to units. Ambulance trains evacuated the French wounded -- up to 800 at a time from brigade and division rear areas. And in 1916, it was rail supported logistics that had the primary sustainment role at Verdun. A single line of light rail had to be constructed into the town because the road network could not handle the necessary tonnage. Supply trains ran at night to avoid German shelling and the Verdun railhead was continually jammed with boxcars.[11]

After World War I, England and France recognized the value of military rail and wanted to retain the expertise. Because of fiscal constraints, they had to consolidate their resources. A combined training facility at Longmoor, England

kept military railroading alive for the Allies until the beginning of World War II.[12]

World War II

World War II witnessed tremendous logistical requirements which stemmed chiefly from the increased consumption of supplies compelled by maneuver warfare. In fact, there was a greater use of strategic, operational and tactical rail in this war than in the previous World War which had relatively static fronts.[13]

Russia relied heavily upon rail to compensate for her lack of trucks. Tanks and other major end items were shipped directly from Russian factories to cities such as Leningrad that were under attack by Germans.[14] These trains were protected by armor plating because they routinely came under fire. The armored trains also provided a degree of self-protection and a means of mobile firepower.[15]

In the European theater, the 727th Railway Operating Battalion (ROB) went ashore at Sicily on July 12, 1943 -- two days after our initial assault forces landed. They restored Sicilian rail operations within 24 hours and began delivering supplies to units of the U.S. Seventh Army. General George Patton awarded the rail unit a commendation for its valiant efforts.[16]

The 713th ROB repaired track and operated trains in the rear of U.S. Fifth Army during its advance from Naples to Rome in 1944. The battalion was in touch with our most forward units in contact. The 727th ROB rebuilt track in Fifth Army's rear during its advance from Rome to Terni, and was subjected to continuous bombing and strafing.[17]

Korean War

During the Korean War, United Nations forces moved by rail to reinforce defensive positions and plug North Korean breakthroughs in our lines. For instance, during the defense of the Pusan Perimeter in 1950, the 25th Division with its attached units was moved approximately 60 miles from Waegwan to vicinity Mason where they arrived in time to block an enemy thrust. The effort took 30 trains composed of 1,500 carloads.[18]

UN forces used rail to gain major tactical advantages over the enemy. When the Wonju-Chun Chon line opened in the center of our front, it marked the first time since the war began that we had a continuous operational and tactical supply line. Later, the line connecting Seoul with Uijonbu and Chorwan became operational. It ran laterally through division rear areas which enabled Army railroaders to push 600 short tons[19] of supplies forward daily. Replacement personnel rode the rails to their division dismount points.[20]

Section Summary

History establishes credibility for the idea of tactical rail. Because it has been employed successfully so many times in the past, it is worthy of consideration when thinking about future conflicts. Armies have been capitalizing on the strengths of railroads almost as long as trains have been in existence.

III. The Case For Tactical Rail

The U.S. Army may be gambling with its tactical logistical potential by virtually eliminating its military rail capability. Planners are assuming sufficient host nation support capability will be available to assist us in future wars. We are further assuming that foreign rail crews will be able and willing to help us accomplish our military objectives. These assumptions are based upon some ideal conditions that may not be realistic, and for which sufficient social organization in the combat area may not exist at the time.

Some governments might not support our military if the survival of their own regime were at stake. Even if a friendly host government were to ask and did receive assistance from our military, that does not necessarily mean

their civilian populace, to include railroad employees, would also be sympathetic or able to cooperate.

Even given a situation in which foreign rail workers were willing to help us, they would not be trained to survive the special circumstances which might arise in a tactical environment. For example, the use of nuclear, biological or chemical weapons would interfere with civil rail operations throughout the entire theater. Until such time that civilian workers could be trained to survive these conditions, military rail would have to be relied upon.

And other considerations come into play. Host nation infrastructure may be inadequate for our purposes, or it may be destroyed by enemy preemptive strikes.[21] It might need assistance in the way of trained personnel, rolling stock and locomotive prime movers. U.S. Army domination of a foreign transport system could result in domestic shortages for the indigenous population. That might turn the people against us. Such a situation could be corrected, without losing logistical support for our forces, only by bringing our own additional rail assets into theater.

Once the shooting starts, we may be unwilling to hand over trains loaded with American equipment and supplies to foreign nationals. The U.S. cannot dictate civilian work schedules nor influence labor unions overseas. Our military leaders may want their logisticians to retain control of the rail system

in the future but, unless we train and equip ourselves now, we will not be in a position to insist on anything then.

Nor can we draft sufficient numbers of U.S. railroad employees into service. That was done during World War II and the Korean conflict when rail companies sponsored military units. But the nature of the American railroad industry has changed. Automation has reduced the number of workers.[22] Employment has been reduced 24 percent from 1965 to 1976, while in 1987, it fell 9.9 percent to only 295,699 and they all will be needed here.[23] Potential recruits with civilian railroad backgrounds have declined 77 percent since 1944. The average age of railroad employees in 1957 was 44.4 years. Today the average age exceeds 50 years.[24] Well beyond the normal draft age.

The preponderance of modern rail equipment in the United States has resulted in a dying out of skills required to operate the older types of engines, rolling stock and maintenance equipment still used elsewhere in the world.[25] Because of the high cost of American railroad labor, trends toward modernization and automation to replace labor are likely to continue.[26]

The presumed speed of modern warfare is another consideration. Even if the railroad work force were large enough, and young enough, we might not have the time to induct them into service, conduct basic training and ship them

overseas. We need to be prepared to fight with the men and equipment on hand at the beginning of the conflict.

So, if we are to take advantage of rail equipment in theater, at least in the early stages of war, some of the older skills will need to be retained by the Army. If we must do the job ourselves at the tactical level, then we need to purchase the necessary equipment now and train the personnel to use it. Our own military is the only reliable source capable of doing the job in a combat environment.

There are other considerations that support the case for tactical rail. General James Van Fleet listed them as survivability, capacity, flexibility and versatility.[27] Today there is an additional factor. That is the anticipated shortage of transportation within combat zones. Rail is one means of reducing those shortfalls.

Survivability of the Roadbed

Railroads are survivable in a theater of operations, however, since the track and ties are fixed in place and traverse large areas, railways are vulnerable to attack. But they also have a way of quickly springing back to life. This is due in part to the simple and uniform construction of track. The ballast, subballast (if used) and subgrade (earth) are not moved easily or significantly modified by explosions. Damage from bombing main lines is usually limited to specific

points on the ground and does not extend over great distances.[28]

General James Van Fleet wrote about the survivability of roadbeds....

> The fact is that there is no fully effective way of putting a railroad out of service and keeping it out of service without disproportionate outlay of time and resources. This has been demonstrated over and over again, in every war since railroads became an important element in warfare. Railway durability and recuperability have become thoroughly established as principles of military doctrine.[29]

Based upon findings from World War I and the Russian Civil War, the Assistant Chief of Staff of the Red Army, V. K. Triandafillov, published railroad restoration rates in 1929. His rate estimations do not exceed six kilometers per day when serious damage has been inflicted on bridges, tunnels, rails and ties. Distances can increase to ten kilometers daily when there is moderate damage and peaks at 20 when damage is light and structures such as towers and bridges have been left intact. These figures today would be significantly better, given modern maintenance of way machinery.[30]

Examples of railroad survivability are numerous,[31] but a particularly instructive one occurred after the U.S. landing at Salerno in 1943. The Germans severely damaged rail lines and rolling stock before their withdrawal. Their systematic demolition, coupled with previous Allied bombing raids, wreaked havoc for miles. American rail units were put ashore

on October 7th and commenced repairs, working within 15 miles of enemy lines. The first train began to resupply forward units by October 10th.[32]

Railroad bridges can be restored more quickly than one might expect. After the Remagen Bridge across the Rhine collapsed in March of 1945, U.S. engineers built, within ten days, a replacement using existing piles of a destroyed bridge at Wesel.[33]

Allied air forces attempted to shut the German railroads down throughout World War II. Trains were often interrupted and delayed but they continued to operate. Operation CLARION, in February of 1945, pitted 9,000 aircraft against high priority targets such as rail lines. But even when the German infrastructure began to crumble, 25 percent of their rail lines -- the key ones they wanted most to keep operational -- continued to operate.[34]

United Nations forces experienced similar frustrations during the Korean War. Operation STRANGLE commenced in August 1951 and lasted ten months. It was an effort by Air Force and Navy air units to disrupt North Korean lines of communication to such an extent that their troops would be unable either to attack or defend. Our attacks centered upon railroad beds, rail bridges and tunnels.[35]

We enjoyed some initial success due to the operation's unexpected nature. But within three months, the North Koreans and Chinese began thwarting our efforts in the face of

continuous bombing of roadbeds. The Reds learned how to repair heavily cratered rail cuts, and could do so during the period of darkness following the attack. They built bypass bridges and employed deception to keep them operational. Bridges were camouflaged in such a way to make them appear destroyed. By the end of December 1951, the Air Force conceded that Operation STRANGLE was failing.[36]

So, in March of 1952, United Nations forces began Operation SATURATE which was aimed at around the clock saturation bombing of rail lines. This forced the Communists into continuous repair efforts but, even so, by May, track was being repaired as fast as we could destroy it.[37]

As was the case in World War II, air power was unable to shut down the North Korean railroads even while air superiority was just about total. The Communists hid rolling stock in tunnels during the day and operated at night. Deception was employed to make our intelligence analysts believe track, bridges and tunnels were destroyed when they were really functional and the enemy made extensive use of bypasses around bridges and tunnels that were really out of business. A determined army will find ways to keep the trains running.[38]

When U.S. forces advanced into North Korea, restoration efforts posed little difficulty for Army railroaders who were experienced civilian railroaders before the war.[39] But it is questionable that this pool of talent still exists today.

Survivability of Rolling Stock

Steps can be taken to improve survivability of rolling stock. It is possible to mount air defense weapons on flatcars and give the crews armor protection. Crew compartments can be armored to protect from strafing aircraft and harassing ground action. Tactical air support from Army attack helicopters and Air Force fighter planes can provide a protective umbrella around trains.[40]

Railcar floors can be sandbagged and windows covered with wire mesh to repel grenades. Locomotives can be placed at the rear of trains to pull undamaged cars clear of the kill zone in an ambush. Idler cars can be pushed in front of lead locomotives to trip any hidden explosive charges and expose concealed derailing devices. Pilot trains can travel ahead of parent trains to check for track damage, booby traps and ambushes. Self-propelled armored railcars are ideal for piloting and patrolling missions.[41]

Germany used quasi-armored trains in World War II. Her soldiers mounted captured French tanks on flatcars and used them to provide security against air, conventional ground and partisan attack while delivering men, equipment and supplies to forward combat areas.[42]

Modern diesel engines are inherently more difficult to put out of operation than the older steam models, which sometimes exploded when the boiler was punctured.[43] Diesel engines

can be lifted out as a pack and replaced in several hours. That can be accomplished under field expedient conditions. (The approach is similar to the engine pack concept, adopted for the M-1 battle tank.) What's more, diesel engines usually operate in series which makes it difficult to put all of them out of commission during a single strafing run.[44]

Capacity

Rail offers greater tonnage capacity than any other mode of transportation except ocean shipping. Because of this quality, its use in war can be very significant even where rail lines are few in number. This is highlighted by the fact that more short tons (STONs) are hauled by rail in the United States today than at any other time in history, even though there has been steady track abandonment over the past several decades.[45] Train payloads are so high they dwarf the capabilities of motor and air.[46]

The Salerno operation, previously referred to, offers further illustration of rail capacity. Within three weeks of this landing, the 713th Railway Operating Battalion was transporting 4,700 STONs daily to U.S. Fifth Army near Caserta. A week later, these deliveries increased to 15,000 STONs.[47] That would be equivalent to almost seven modern day medium truck companies,[48] which is more transport capability than is found in any of today's active corps.

Flexibility in the Number and Type of Railcars

Flexibility is another inherent strength of rail. Diversity in the type of railcars and train compositions available provide a variety of options to the tactical commander.[49] Tank cars can provide the large volume of bulk petroleum needed by combat forces. Boxcars can be used for all classes of supply and can protect goods from weather and pilferage. Refrigerator cars can transport class A rations.

Troop trains can be equipped with kitchen cars and sleeping compartments so combat troops arrive at their destinations well fed and well rested. A real advantage in a fight. Light infantry divisions may have to rely on rail movement because their organic transport is austere. Railcars are ideal for transporting large formations in the combat zone or shifting them laterally behind the front. Because of their large size, trains provide better tactical cohesion than do buses and trucks. This same concentration has the disadvantage, however, of being a lucrative target. Special cars with secure floors, sides and ceilings can be used to transport prisoners of war.[50] In short, trains can be uniquely tailored to meet the needs of the tactical situation.

Hospital trains may provide a solution to problems currently facing medical planners. Combat support hospitals are normally field sited in the corps area while mobile army surgical hospitals are found in the corps forward or division

rear areas.[81] But depending on the tactical situation, they can be overrun or get so far behind units in contact that responsive service is not possible.

Hospital trains might help by accepting wounded close to units in contact. Casualties could then be evacuated at the same time medical care was being received. But the success of such an operation would depend on a great extent on how well the enemy adhered to the Geneva Convention about the protection to which medical facilities are entitled.

Flexibility in Location

Flexibility in location is another inherent advantage of railcars. They can be dropped off at different locations, even in forward areas. Train density permitting, tunnels can be used to provide temporary cover and concealment for cargo until transloading to truck can occur. Army engineers can improvise by making dirt/log sideramps along rail spurs to allow loading or unloading in forward locations.[82]

Locational flexibility can be further increased with the use of temporary track. That type of track, nicknamed "shoo-flies" by soldiers laying it, was constructed in France during the 1940s and in Korea during the early 1950s to support combat operations. Locational flexibility makes it possible to restore track quickly and bypass problem areas.[83] And rail traffic, with its inherent system of

signals and controls, is much easier to reroute than is truck transport.

Versatility

Rail has a better all-weather capability than other modes of transportation. Trains operate through deep snows and torrential rains. They can keep rolling in bad weather that would shut down motor and air entirely. Rail might be particularly valuable in tactical situations when the weather conditions are such that the enemy does not expect us to press the offensive. And rail can operate over almost any type of terrain, including deserts, permafrost, mountains and plains.[24]

Transportation Shortfalls in the Combat Zone

Additional military rail capability will be needed in future conflicts when all forms of transportation, to include host nation support, are stretched to their limits. For reasons previously discussed, military assets are the most reliable means of transport in areas forward of the corps rear boundary, otherwise known as the combat zone. What host nation support (HNS) is available will likely be found behind the corps rear boundary in an area called the communications zone (COMMZ), but HNS cannot be counted upon in the combat

zone.[53] To plan otherwise in peacetime will likely cause confusion and further logistical constraints in wartime.

There are numerous ways to estimate logistical requirements, but perhaps one of the best is to use a study completed by the Army Logistics Center in September 1987. The Center made an extensive effort to develop realistic planning factors based on a notional corps composed of five divisions, three separate brigades and an armored cavalry regiment (ACR). Daily consumption averages are based upon the first 30 days of combat in Western Europe.[54]

It is estimated the entire notional corps will consume 36,708 STONs of dry cargo (Appendix J) and 2.935 million gallons of petroleum (Appendix C) on a daily basis at intense levels of combat.[57] Theater army and corps transportation assets will throughput this cargo to consignees inside the combat zone, thereby minimizing transloading to subordinate unit vehicles. The corps support command has been given a realistic amount of transportation resources -- a motor transport group -- but that alone is not enough to do the job.[58]

The transport group trucks can move 18,240 STONs of dry cargo (or 50 percent of the total STONs needed) and 900,000 gallons of petroleum (or 31 percent) within the combat zone (Appendix A).[59] The shortfalls in tonnage will have to be handled by theater army assets.[60] (And that may not be possible since theater army assets depend so heavily upon host

nation support in the COMMZ.) These problems are not overstated. If anything, the projections are overly optimistic. The scenario assumes that no attrition to support vehicles occurs.[41]

That portion of the cargo destined for the combat zone is delivered by theater army and corps vehicles. Normally, it proceeds no further than the main support battalions (MSBs) in division rear areas. If the combat situation has stabilized, and if forward support battalions (FSBs) are not relocating, then the goods can be sent into the brigade rear. Cargo going to separate brigades or the ACR will be sent to their respective support battalions or support squadron.[42] Ammunition is an exception because its destination is either an ammunition supply point (ASP) located in the corps/division rear, or an ammunition transfer point (ATP) in the division/ brigade rear area.[43]

An estimated 9,411 STONs of dry cargo (Appendix Q), excluding ammunition, and 1.574 million gallons of petroleum (Appendix G) will be needed each day in the combat zone by the divisions, separate brigades and ACR.[44] Once the supplies reach their intended destination on theater army and corps vehicles, the combat units have only enough organic capability to move 6,761 STONs (or 72 percent of the total STONs needed) and 1,086,500 gallons (or 69 percent) of this materiel forward to the maneuver battalions each day (Appendix B).[45]

This, once again, assumes optimal conditions with no attrition to logistical vehicles. Movement of ammunition from the ASPs and ATPs forward is to be accomplished by specially designed tactical vehicles that are organic to maneuver battalions.[44] Shortfalls in this area are also likely, but they have not been factored into the calculations. The realities of combat are likely to prove these transportation shortages at corps and division to be understated.

It is unrealistic for military leaders to dismiss these shortfalls. The combat arms cannot fight without logistical support and host nation support is not the complete solution. Greater reliance upon military railroading is no panacea either, but at least it will provide another reliable source of transport, even in the combat zone, and one which has great potential for expansion.

Section Summary

The case for military rail rests on two considerations. First, there are no guarantees our Army would receive an acceptable level of support from any host nation. We must be prepared to do the job ourselves. Second, railroads can survive the hardships of modern war to deliver the supplies in realistic volume to the combat zone. Indeed, perhaps this mode of transportation can support modern tactical operations more effectively than either trucks or airlift.

IV. Counterarguments to the Case Against Tactical Rail

There have been numerous reasons for eliminating railroad units from the Army's force structure. These considerations must be dealt with before one can recommend reactivating units and increasing the number of military railroad personnel.

Budgetary Constraints

Budgetary constraints are one such factor. Railroad systems are capital intensive and the initial outlays for roadbeds, rolling stock and locomotives are high. But one must consider other factors than just money when comparing alternative means of transport. Capacity and potential for expansion in time of war must also be included. The Germans in the interwar years felt they could afford to invest heavily in rail to support their Blitzkrieg plans, because the use of trucks to provide comparable lift would be too expensive.[47]

Because rail was a going concern within the U.S. Army at one time, reactivation of rail units would not be as expensive as starting from scratch. The Army has retained skeletal assets for training purposes at Fort Eustis, Virginia. What's more, outdated equipment, no longer used by civilian industry, would be relatively cheap to purchase. It would permit teaching of basic maintenance and operating principles while familiarizing soldiers with older equipment still used

elsewhere in the world.[49] This has practical advantages. If we were to deploy into an underdeveloped theater, Army railroaders would already be trained to take over the transport system as the situation warranted.

Vulnerability

Another argument against tactical rail is its vulnerability to air and ground attack. Because roadbeds, track, bridges, tunnels and stations are fixed targets, they are easy to hit with artillery and aircraft ordnance. Railroads were one of the most dangerous modes of transport during World War II because rail facilities made lucrative targets. For this reason, one author predicted that World War II would be the last war that rail would play a role...."The day of the military railroad is over".[50]

Counterarguments need not reject the basic premise about the ease of attack against rail targets, but the conclusion that the day of the military railroad is over does not necessarily flow from that premise. (See Section III.) All transportation facilities are by their very nature vulnerable to attack. Railheads are no more exposed than airheads, ports and trailer transfer points. Roadbeds and track are no more subject to attack than are roads. Bridges and tunnels are as easy to destroy whether they are designed for trains or motor vehicles. Tactical wheeled vehicles have great difficultly

operating over rough terrain. Heavily laden trucks are restricted to roads just as much as trains are to track.[70] Yet no one argues that truck battalions should be eliminated because of their vulnerability.

What's more, the active defensive measures discussed earlier (pilot trains, idler cars, air defense weapons, etc.) provide a degree of physical protection for locomotives and railcars. Used in conjunction with passive measures (armor plating, dispersion of rolling stock, rerouting of trains to avoid areas of enemy penetration or insertion, etc.), rail vulnerability can be kept to a minimum.

Susceptibility to Guerrilla Attack

Rail operations can be disrupted by special operations or guerrilla attack. The French partisans during World War II were successful in delaying troop transport and logistical trains moving across France. Hit and run tactics made it difficult for the combat units on board to react quickly. When the German trains finally did arrive at their destination, units were late, partially destroyed and had sometimes lost cohesion.[71] But countermeasures were taken.

And those countermeasures which the Germans adopted have direct application today. They placed a tank in operational condition and complete with crew, on a flatcar at the front of the train. The flatcar had an end ramp attached to allow

speedy offloading in case of ground attack. Troops aboard the train rehearsed ambush drills which permitted fast detraining and assumption of defensive positions. Together, the infantry and armor maneuvered against the partisans. The train could resume its normal course after the men and equipment had reloaded, unless the track had been damaged. But the train carried repair supplies and when necessary, the men set about performing maintenance of way.[72] We need to train people to do that.

Ease of Track Destruction

Effective means of destroying track during retrograde operations are available. The "Trackwolf" in World War II was used by the German Army in Russia and Italy to quickly break rail ties, thereby making track useless to pursuing forces. A large steel hook mounted on a flatcar was lowered into position between wooden rail ties. As the train moved out, all the ties were ripped up behind it -- simple and effective. Antipersonnel mines at irregular intervals inhibited efforts to restore the line.[73]

Equipment like the "Trackwolf" could take a terrible toll on roadbeds in a future war. In a high intensity conflict today, battlefields are expected to be nonlinear. Forces will be mobile and fronts extremely fluid.[74] Temptations to destroy track as units pull back will be great, regardless of

the fact the lines may be needed later as these same forces move forward. Track may be so badly damaged throughout the theater that tactical rail operations may not be possible for a time.

But there are counterarguments to that concern too. With modern maintenance equipment, repair is easier and faster than it was in World War II. Several machines can do in hours what it formerly took a maintenance of way gang days to accomplish. Ties and steel rail can be laid quickly and effectively. Automatic rail lifters, trade jacks and spikers have not only reduced the size of rail crews, but have made them more productive than ever before.[73] There will be challenges, however, in getting the repair equipment, supplies and trained personnel to the right places at the right times. They must be obtained now and units must be trained now.

Maintenance of Way Requirements

The maintenance of railroad track can eat into personnel resources. And so can the repair of roads. In World War I, for example, the main vehicle supply route to Verdun -- a narrow secondary road that ran 40 miles from Bar-le-Duc to the front lines -- needed approximately one man per meter to keep the line operational.[74]

Repair of bridges and tunnels can require major commitments. The Savone River crossing in Italy during World

War II is a case in point. The Army Corps of Engineers replaced a ten-arch bridge with 130,000 cubic yards of dirt to protect against sabotage and ensure the line between Naples and Rome remained open.[77] But they did get it done.

We must realize that modern maintenance equipment does the job more effectively and efficiently than ever before. Modern earthmoving and digging machines can repair tunnels, cut and fill mountainsides in record time. Railroad maintenance is just as doable as are the things done to keep the roadways open. Efforts should be focused where payoffs will be greatest in terms of tonnage capacity.

Section Summary

Numerous arguments seem to support the status quo -- the complete elimination of Army railroading from the active Army force structure. Total abandonment, however, would be a mistake. Strong points can be made to counter the case against tactical rail. But before drawing any final conclusions about the reactivation of railroad units, several other factors need to be examined. The current state of military units is one. Clearly, present transportation capabilities need to be matched against anticipated requirements to determine the extent of shortfall. Only then will a full appreciation of the necessity of rail be possible and its potential contributions placed in proper context. We

need to make that comparison now. We cannot stipulate that we are going to abandon military rail unless we can demonstrate that realistic transportation requirements can be met better and more fully without it.

V. Current State of Military Rail Units

Today, the United States Army is very limited in its ability to conduct military rail operations -- more limited than one might initially believe, given the names of our railway organizations. While there has been a decline in military rail capabilities since the end of the Korean War, there has been no corresponding decrease in logistical requirements.[78] This has created shortfalls in transportation today that may absolutely demand more railroad capacity, not less.

The 143rd Transportation Command

The 143rd Transportation Command (TRANSCOM) is an Army Reserve formation headquartered in Orlando, Florida.[79] It is a functional command with the mission of providing all modes of transportation within the theater of operations. The 143rd staff includes a rail section that assists with the execution of these duties. Doctrinally, a TRANSCOM is directly subordinate to a theater army headquarters and has

railway brigades, groups and battalions assigned to it.[80] The only rail units assigned to the 143rd, however, are the 416th and 757th Railway Battalions [81]

The 416th Railway Battalion in Jacksonville, Florida is nothing more than a composite of Army Reserve transportation teams totaling only 45 personnel. Only one of them, Team EB, pertains to railroading. (The team is a rail terminal detachment that performs terminal documentation functions.) The remaining teams provide the administrative skills necessary to carry out the battalion's contingency mission of interfacing between commercial rail companies and maritime shipping at an overseas ocean terminal.[82] The 416th can do little to support tactical units directly.

The 757th Railway Battalion in West Allis, Wisconsin is organized in accordance with Field Manual 55-20: Army Rail Transport Units and Operations.[83] Its subordinate units are in the Army Reserve and include the: 226th Railway Engineering Company (Granite City, IL), 1150th Railway Equipment Maintenance Company (West Allis, WI), 1151st Train Operating Company (West Allis, WI) and 1152nd Railway Equipment Maintenance Company (West Allis, WI).[84]

The 757th Railway Battalion is the only unit we have that can exercise the four primary functions of rail: train operations, maintenance of way, maintenance of equipment and train control. It has the capability to operate and maintain

one division of track. The battalion can dispatch trains and operate stations, signal towers, yards and terminals.[65]

A railway battalion can operate ten trains daily in each direction over single track and 15 trains over double track. Military planners today figure trains in a theater of operations will average 20 cars apiece and net a total of 400 STONs of dry cargo or 120,000 gallons of petroleum.[66] Actual tonnages will vary depending on the particular scenario, but one can generally plan on the 757th Railway Battalion moving 4,000 STONs a day (or 1,200,000 gallons) in one direction over a single main line and 6,000 STONs (or 1,800,000 gallons) over a double line.[67] Field Manual 101-10-1/2 provides a slightly more optimistic planning figure of 500 STONs per train, which increases the totals to 5,000 STONs daily in one direction over a single line and 7,500 STONs over a double line.[68] And that is presently the Army's entire roadway capacity.

The 757th has the capability of resupplying 16 to 20 percent of the dry cargo needed by the notional corps and 61 percent of its petroleum needs. This assumes the corps is engaged in intense combat, double track is available and lines of communication do not exceed 150 miles.[69] According to the U.S. Army's Transportation Master Plan, that is still insufficient to meet requirements in contingency theaters.[70]

Other challenges exist for the 757th Railway Battalion.[71] There are few opportunities for train crews to

exercise main line operating skills. The unit has no roadway locomotives, only switch engines for yard use. Critical shortages in rail specialties exist because Reservists cannot be absent from their civilian jobs for the extended periods of time required for rail training. Despite all that, contingency plans task the 757th to operate almost two divisions of rail in an overseas theater -- twice their doctrinal capability.[32]

Miscellaneous Rail Units

Two other military rail units do exist. But neither one has an overseas deployment mission and therefore, they cannot directly impact on tactical sustainment efforts.

The 1205th Railway Services Unit in Middletown, Connecticut is a TDA organization in the Army Reserve. Upon mobilization, the 1205th will be stationed at Sunny Point, North Carolina. This rail unit will operate yards, maintain track in the vicinity of the port and interface between commercial rail companies and the maritime shipping industry.[33]

The 171st Movement Control Detachment in Yermo, California is the active Army's only operating rail unit. It is a TDA organization that is authorized 15 personnel and three switch engines. The 171st receives commercial trains and performs the necessary yard work to support armored and mechanized

units rotating in and out of the National Training Center (NTC) at Fort Irwin, California. The detachment's mission is likely to expand in the years ahead when 35 miles of track, connecting Yermo with the NTC, is built under U.S. Government contract. It is anticipated that the 171st will receive several 120 ton road engines to operate the main line in addition to the yards.[24]

Phases of Operation

Another approach to determining the current state of military rail units is to examine doctrinal requirements and compare them to our present capabilities. U.S. Army doctrine specifies three phases of Army railroad operations that categorize the degree of military involvement in theater rail operations. The phases do not have to be carried out sequentially, nor do they imply any type of operational priority.[25] Phase I is defined below.

> Only military personnel conduct phase I operations. Personnel use this phase during the early stages of a military operation. Phase I is used in or near the combat zone where military need and security restrict the employment of civilians.[26]

Phase I recognizes the necessity of tactical rail, particularly in the early stages of conflict. Phase II is a joint civilian-military effort where both commercial rail

firms and the U.S. Army operate trains and maintain the rights of way. Doctrine requires this be accomplished under an umbrella of American military leadership and supervision. In phase III, indigenous railroad personnel operate and maintain the rail system under the supervision of Army leadership. Normally, phase II and III take place in the communications zone. These phases are essentially economy of force measures to free military railway units from COMMZ obligations so they may operate further forward in the combat zone."[7]

Our ability to perform phase I, II and III operations in a theater of war rests solely with the 757th Railway Battalion which has never operated a rail division. Our capability to conduct more than one phase simultaneously is questionable because of the Army's limited rail assets.

Section Summary

Currently, there are significant incongruities between U.S. Army doctrine and military rail capabilities. Our present force structure (wholly in the Army Reserve) cannot support the three phases of military railway operations as outlined in Field Manual 55-20. Nor do we have the personnel trained and equipment on hand to carry out even one of the phases significantly. The current state of our military rail program is inadequate to meet even modestly projected requirements and is not organized to comply with our own

published doctrine. Significant transportation shortfalls will exist in war so rail should be expanded now to narrow this certain gap in our capabilities. Little progress however, is being made in that direction.

VI. Conclusion

Army railroading has applications at the tactical level of war. Its great capacity -- unmatched by any other mode of land transportation -- enhances the combat commander's ability to mass men, equipment and supplies at the critical point of battle. In past wars, trains have proven to be reliable, even though the fixed nature of the roadbed and concentrations of rolling stock laden with cargo are lucrative targets for the enemy.

There is no question that railroads can be temporarily put out of commission with the use of modern, precision guided munitions, by partisan action or even enemy special forces. All fixed transportation structures for that matter, to include roads, airfields and maritime ports, are just as vulnerable. But there is a difference. For railroad beds, interdiction efforts are more quickly overcome for reasons of durability and flexibility discussed earlier.

Ways have been discussed to improve the security of locomotives and railcars. These methods can probably get the job done even if, like anything else, they are not successful

100 percent of the time. Of course, when these protective measures do fail, much cargo can be lost because of the tonnage concentrations in one area.

Risks and physical danger in the combat zone can never be eliminated entirely. Rail assets will take hits, as will other units. Tactical success will reduce this risk and rail transport will increase the likelihood of tactical success. How much will be a direct result of carefully thought out tactical plans which are supported by a responsive logistics structure. Railroads can contribute, tactically and significantly because of their inherent flexibility, versatile nature and large capacity.

Because the advantages of tactical rail outweigh the disadvantages, an expansion beyond our present meager capabilities is warranted. And building up our rail units should not be done at the expense of other modes of Army transportation either -- those too are needed to reduce anticipated tonnage shortages. Major General Wheeler, Commandant of the Industrial College of the Armed Forces, wrote in 1986 that,

> At corps level over the long term, rail is the preferred method of support due to the magnitude of the support problem....The optimum method is for attacking units to secure rail lines up to the brigade rear areas. These could then be rapidly repaired.[9]

Only the degree to which military railroading should be expanded requires further study. The number and type of rail units that can be justified in the active Army, National Guard and Army Reserve are a function of the war planning process. There are numerous variables that impact on the proposed expansion.

Likely locations of future conflicts are a major consideration. Theater commanders know their anticipated resupply requirements and projected transportation capabilities. Tonnage shortfalls will drive transport needs that can be filled in part by rail, depending on the available railroad infrastructure in theater. A war on the European continent, for instance, will allow for greater use of railroads than a war in Central America with its less developed track network.[**] But the use of Army rail in Central America might be even more critical due to a limited motor road net and limited host nation capability for support.

Other factors include the number of theaters that are concurrently active around the world, the intensity of battle and numbers of committed ground and air forces. The degree of responsiveness required will determine what is necessary for the active Army and what should go to the National Guard and Army Reserve. Until these variables are thoroughly analyzed, no informed decision can be made regarding the future of Army railroading. One point is clear, however. What we have on hand now will barely keep one heavy division and separate

mechanized brigade resupplied, even under the most optimal of conditions (Appendix R). That is a serious shortcoming, considering the worldwide commitments of our armed forces.

Some corrective action could be taken, at least as an interim measure, while these war planning considerations are being sorted out. The problem of personnel shortages in Army Reserve railroad units might be eased by making changes in the enlisted skill qualification process. Few Reservists can afford to be away from their civilian occupations for the long periods of training now required.[100] Since the Transportation School at Fort Eustis uses civilian contractors to teach technical courses for enlisted personnel, new programs of instruction could be generated by private industry. The Reservists could be better accommodated by offering correspondence work and classroom instruction, designed to be taught over a period of years.

Training of active Army and Reserve Transportation officers is accomplished during the basic and advanced courses. Supplemental rail courses could be added to the curriculum to award additional skill identifiers. The Training With Industry Program could be expanded to give more active officers experience working with rail companies at home and abroad. That would be excellent preparation for the supervisory requirements levied by phase II and III operations overseas.

Greater use can be made of the Research and Locomotive Evaluator/Simulators (RALES) to train locomotive engineers.[101] This will avoid the liabilities of on the job training with commercial firms and reduce the need for buying additional main line engines for the Army. The 757th Railway Battalion has already used a Department of Transportation RALES unit in Chicago with great success.[102]

Exciting new approaches to rail training could be adopted for military rail units. Joint training overseas could be carried out in conjunction with our allies around the world. Army railroaders could refine their skills at Fort Eustis and the National Training Center. The 226th Railway Engineering Company and 1205th Railway Services Unit maintenance of way gangs could receive on the job training by working on the Fort Eustis track which is in desperate need of repair. This same company could also assist in the building and future maintenance of the Yermo-NTC line. The 1151st Train Operating Company could receive main line training on this same stretch of track once it is completed. The 1150th and 1152nd Railway Equipment Maintenance Companies could be gainfully employed by helping maintain the Department of Defense railcar fleet. Not only would valuable on the job training be accomplished, but costs to the federal government would be reduced.

Improving and maintaining the proficiency of Army Reserve railway units is important. They represent a scarce resource which needs to be expanded. Before that can be accomplished,

however, senior military leaders should systemically reevaluate their transportation needs to include rail. Then a new and better mix of transport capability can be organized within the Army force structure. That will allow logisticians in wartime to take advantage of the inherent strengths of rail to better tailor transport plans to the tactical commander's needs.

For years, attempts to make fundamental improvements in the Army railroading program have not been successful. Because rail has been relegated to such a low priority in the Army of Excellence upgrades, it is unlikely that any major changes will occur in the immediate future. What is needed most is attention focused at the highest levels of the Army to provide central direction of transport needs, including rail. Without that, military rail will be subject to continued drifting and the target of even further reductions.

ENDNOTES

ENDNOTES

[1]An early use of tactical rail was during the Franco-Austrian War in 1859. French soldiers were transported from Genoa directly to the battlefield at Montebello. James A. Van Fleet, Rail Transport and the Winning of Wars (1956): p. 14.

[2]Department of the Army, Field Manual 100-5: Operations (1986): pp. 10, 11.

[3]Ibid., p. 10.

[4]Telephone Interview with Dr. Alfred C. Mierzejewski, Command Historian, TRADOC (Training and Doctrine Command) Test and Experimentation Command (TEXCOM), Fort Hood, Texas, June 27, 1988.

[5]Van Fleet, op. cit., p. 3.

[6]Each mode of transportation has its own inherent strengths and weaknesses that are situationally dependent. Some distinguishing characteristics between different types of transport are as follows: (1) Rail is the most efficient way to haul large amounts of cargo and can be used in all types of weather. (2) Motor is the most flexible mode after helicopter transport. (3) Inland waterway is the most economical mode in terms of fuel consumption. Department of the Army, Field Manual 100-10: Combat Service Support (1988): pp. 9-3 to 9-5.

[7]Telephone Interview with Mr. George R. Hart, Chief, Training Management Division, United States Army Transportation School, Fort Eustis, Virginia, July 8, 1988. The last active U.S. Army railway unit was deactivated in June 1972. Lewis I. Jeffries, "The Importance of Military Railways in Future Conflicts" (1975): p. 11.

[8]Department of the Army, Field Manual 100-5: Operations (1986): pp. 59, 60.

[9]Hew Strachan, European Armies and the Conduct of War (1985): p. 121; George E. Turner, Victory Rode the Rails: The Strategic Place of the Railroads in the Civil War (1953): pp. 66, 86 - 88; Van Fleet, op. cit., p. 14.

[10]Robert C. Black, The Railroads of the Confederacy (1952): pp. 189 - 191; Strachan, op. cit., p. 121; Turner, op. cit., pp. 285 - 286; Van Fleet, op. cit., p. 15.

[11]Denis Bishop and W.J.K. Davies, Railways and War Since 1917 (1974): pp. 2, 93.

[12]Ibid., p. 97.

[13]Ibid., p. 3.

[14]Ron Ziel, Steel Rails to Victory: A Photographic History of Railway Operations During World War II (1970): pp. 63, 71.

[15]Bishop and Davies, op. cit., p. 110; Telephone Interview with Dr. Alfred C. Mierzejewski, Command Historian, TRADOC (Training and Doctrine Command) Test and Experimentation Command (TEXCOM), Fort Hood, Texas, June 27, 1988.

[16]Van Fleet, op. cit., pp. 23, 24; Ziel, op. cit., p. 130.

[17]Ziel, op. cit., p. 130.

[18]Van Fleet, op. cit., p. 30.

[19]A short ton is a unit of weight equivalent to 2,000 pounds. Random House College Dictionary (1980): p. 1383.

[20]Van Fleet, op. cit., p. 23.

[21]The West German railroad infrastructure is adequate for U.S. military purposes. The Germans have an extensive track system and an active fleet of locomotives and railcars. Their territorial commands are well trained and equipped to support us. Rail shortfalls are anticipated, however, in the less developed countries and Third World.

[22]Personal Interview with Colonel Lewis I. Jeffries, Director of Academic Operations, Command and General Staff College, Fort Leavenworth, Kansas, July 8, 1988.

[23]The 9.9 percent drop in employment pertains to Class I railroads, or those rail companies which have at least $87.9 million in annual operating revenues. Association of American Railroads, Railroad Facts: 1988 Edition (1989): p. 3; "Little Book, Big Message", Trains (July 1988): p. 5; C.J. Schwendiger, "Is This the End of the Line for TRS? Can the Nation Afford It?", Defense Transportation Journal (December 1976): p. 16.

[24]Telephone Interview with Mr. George R. Hart, Chief, Training Management Division, United States Army Transportation School, Fort Eustis, Virginia, July 8, 1988.

[25]Most of the railway equipment in Western Europe and Southwest Asia is technologically on the same level with the

U.S. rail industry. This is not the case, however, in most other parts of the world -- particularly in the Third World. Because of our Army's lack of training on foreign made rail equipment, difficulties will ensue from attempts to operate and maintain it. Telephone Interview with Lieutenant Colonel Michael J. Swart, Senior Rail Staff Officer, 143rd Transportation Command, Orlando, Florida, January 10, 1989.

[24]Telephone Interview with Mr. George R. Hart, Chief, Training Management Division, United States Army Transportation School, Fort Eustis, Virginia, July 8, 1988; Personal Interview with Colonel Lewis I. Jeffries, Director of Academic Operations, Command and General Staff College, Fort Leavenworth, Kansas, July 8, 1988. Not only are worker skills dying out, but so too are the locomotives and rolling stock. Sufficient amounts of rail equipment did not exist, even 30 years ago, to support wartime expansion, and the situation is worse today. Lewis I. Jeffries, "U.S. Railroads -- A Military Asset" (1985): p. 8; United States Congress, Hearings Before a Subcommittee of the Committee on Armed Services, House of Representatives: Adequacy of Transportation Systems in Support of the National Defense Effort in Event of Mobilization (October 10, 1959): p. XII.

[27]Van Fleet, op. cit., pp. 21 - 63.

[28]Department of the Army, Field Manual 55-20: Army Rail Transport Units and Operations (1986): p. 7-2; Lewis I. Jeffries, "The Importance of Military Railways in Future Conflicts" (1975): p. 5. General Van Fleet had a great deal of experience with military railroads during the Korean War. In his opinion, the inherent resistence of roadbeds "to disabling damage or destruction, and its ability to make a quick comeback to volume operation -- are astonishing; in fact, almost unbelievable to one who has not witnessed the evidence. At first glance it might appear that a railroad is highly vulnerable to attack, because its line and rolling stock are in plain sight, hard to conceal or disguise, immovable as to track, and trackbound as to rolling stock. Nothing could be further from the facts." Van Fleet, op. cit., p. 31.

[29]Van Fleet, op. cit., pp. 11, 12. Roadbeds are able to withstand the ravages of a nuclear environment. In 1956, Major General Charles G. Holle, Deputy Chief of Engineers, U.S. Army, stated that even "under the atom bombs which fell on Hiroshima and Nagasaki, railroad-type structures stood up among the best". Ibid., p. 5.

[30]V.K. Triandafillov, Nature of the Operations of Modern Armies (1929): p. 176. Prefabricated sections of ties and rail, called track panels, are a modern invention that allow

for the rapid replacement of destroyed track. The panels may be constructed of various length, placed on a flatcar, dropped into place and then spiked down. Telephone Interview with Mr. Anthony T. Newfell, Railroad Equipment Specialist, Transportation Systems Center, United States Department of Transportation, Cambridge, Massachusetts, January 12, 1989.

[31]Another World War II example of roadbed survivability concerns German rail. They frustrated our efforts over a four year period to bomb the Bielefeld Viaduct. This railroad bridge in Northern Germany connected North Sea ports with the Ruhr industrial area. Unable to score a direct hit, finally an "earthquake bomb" weakened its structural supports in 1945. But the Germans had anticipated this happening and had already built and camouflaged a double track diversion nearby. Even though railways are sitting ducks in many ways, creative planning for the anticipated loss of key bridges and tunnels can minimize the impact on operations. Denis Bishop and W.J.K. Davies, Railways and War Since 1917 (1974): p. 111.

[32]Van Fleet, op. cit., p. 24.

[33]James A. Huston. Army Historical Series: The Sinews of War -- Army Logistics, 1775 - 1953 (1966): pp. 534, 535; Van Fleet, op. cit., p. 41. Steps were taken to speed the repair of railroad bridges as far back as the War Between the States. Engineers developed "ready-made bridges and trestles constructed on an assembly-line technique". Our restoration capabilities have continued to improve since then. Thomas Weber, The Northern Railroads in the Civil War, 1861 - 1865 (1952): p. 225.

[34]James A. Van Fleet, Rail Transport and the Winning of Wars (1956): p. 37.

[35]Ibid., p. 7.

[36]Ibid., pp. 7, 8.

[37]Ibid., p. 8.

[38]Ibid., pp. 7, 8.

[39]Ibid., p. 41.

[40]Telephone Interview with Lieutenant Colonel Michael J. Swart, Senior Rail Staff Officer, 143rd Transportation Command, Orlando, Florida, January 10, 1989.

[41]Department of the Army, Field Manual 55-20: Army Rail Transport Units and Operations (1986): pp. 3-4 to 3-6.

[42]Bishop and Davies, op. cit., p. 111; Telephone Interview with Dr. Alfred C. Mierzejewski, Command Historian, TRADOC (Training and Doctrine Command) Test and Experimentation Command (TEXCOM), Fort Hood, Texas, June 27, 1988.

[43]Bishop and Davies, op. cit., p. 107; Van Fleet, op. cit., p. 37. Coal-burning steam engine skills still have some advantages for the U.S. Army. Even though they are inherently more vulnerable, there are countries which use them. If American railroad units were trained to operate steam locomotives, we would have assets already available in country. That would permit almost immediate operations in a combat area, while our own rail equipment followed later by sea.

[44]Van Fleet, op. cit., pp. 37, 38.

[45]"Railroads", The American Society of Transportation and Logistics Pro-Development Letter (July 1988): pp. 1, 2.

[46]Lewis I. Jeffries, "The Importance of Military Railways in Future Conflicts" (1975): p. 5.

[47]Ron Ziel, Steel Rails to Victory: A Photographic History of Railway Operations During World War II (1970): p. 130; Van Fleet, op. cit., p. 24.

[48]One medium truck company can haul 2,250 STONs of dry cargo, based on two round trips per day within a 40 to 100 kilometer radius at 75 percent availability. United States Army Command and General Staff College, Student Text 101-6: G4 Battle Book (1988): p. 4-28.

[49]Lewis I. Jeffries, "The Importance of Military Railways in Future Conflicts" (1975): p. 6.

[50]Van Fleet, op. cit., p. 45.

[51]Telephone Interview with Major Charles M. McNeilly, Health Systems Analyst, Directorate of Combat Developments, Academy of Health Sciences, Fort Sam Houston, Texas, February 10, 1989; United States Army Command and General Staff College, op. cit., pp. 4-3, 4-4.

[52]Van Fleet, op. cit., p. 47.

[53]Van Fleet, op. cit., pp. 48, 49.

[54]Van Fleet, op. cit., pp. 63, 64.

[45]Department of the Army, Field Manual 100-16: Support Operations: Echelons Above Corps (1985): p. 1-4. Although host nation support (HNS) is normally limited to the communications zone, in the Federal Republic of Germany, HNS agreements specify that West German trains will carry American equipment, supplies and personnel into our corps' areas.

[46]United States Army Logistics Center, Logistics Planning Factors: Notional Corps (1987): p. i.

[47]Ibid., pp. 37 - 64.

[48]Department of the Army, Field Manual 63-4: Combat Service Support Operations -- Theater Army Area Command (1984): p. 6-2; Department of the Army, Field Manual 63-5: Combat Service Support Operations -- Theater Army (1985): pp. 6-1, 6-2, 6-6 to 6-8; Department of the Army, Field Manual 100-10: Combat Service Support (1988): pp. 9-10 to 9-13; Department of the Army, Field Manual 100-16: Support Operations -- Echelons Above Corps (1985): pp. 6-72 to 6-74.

[49]United States Army Command and General Staff College, op. cit., pp. 4-28, 4-29, 4-31, 4-32.

[50]Department of the Army, Field Manual 63-4: Combat Service Support Operations -- Theater Army Area Command (1984): p. 6-2; Department of the Army, Field Manual 63-5: Combat Service Support Operations -- Theater Army (1985): pp. 6-1, 6-2, 6-6 to 6-8; Department of the Army, Field Manual 100-10: Combat Service Support (1988): pp. 9-10 to 9-13; Department of the Army, Field Manual 100-16: Support Operations -- Echelons Above Corps (1985): pp. 6-72 to 6-74. In West Germany, tonnage shortfalls at corps level and below can be alleviated by theater army and host nation support (HNS) assets, because HNS is available in the corps areas.

[51]United States Army Logistics Center, op. cit., pp. i - 64.

[52]Department of the Army, Field Manual 63-1: Combat Service Support Operations -- Separate Brigade (1983): pp. 5-6 to 5-18; Department of the Army, Field Manual 63-2-2: Combat Service Support Operations -- Armored, Mechanized and Motorized Divisions (1985): pp. 5-6 to 5-13; Department of the Army, Field Manual 63-3J: Combat Service Support Operations -- Corps (1985): p. 7-8; Department of the Army, Field Manual 63-20: Forward Support Battalion -- Armored, Mechanized and Motorized Divisions (1985): pp. 5-5, 5-8, 5-11, 5-15; Department of the Army, Field Manual 63-21: Main Support Battalion -- Armored, Mechanized and Motorized Divisions (1986): pp. 5-3 to 5-5.

[43]United States Army Command and General Staff College, op. cit., pp. C-1 to C-3.

[44]Only the stated amounts of dry cargo and petroleum are needed inside the combat zone. The other 27,297 STONs (36,708 - 9,411) and 1.361 million gallons (2,935,000 - 1,574,000) remain in the COMMZ. In the case of ammunition however, the tonnage is destined for ASPs and ATPs (Appendixes J and K) and is not included in the 9,411 STONs. It is also important to note that the 9,411 STONs of dry cargo and 1.574 million gallons of petroleum apply only to the sustainment requirements of divisions, separate brigades and the ACR. These figures do not include the logistical needs of nondivisional combat support units normally found at corps level (i.e., corps artillery and engineers, both of which are high tonnage consumers).

[45]United States Army Command and General Staff College, op. cit., pp. 5-6, 5-10, 5-19, 5-23; Telephone Interview with Major James E. Myers, Deputy, Logistics Assessment Task Group, United States Army Logistics Center, Fort Lee, Virginia, July 8, 1988. It should be noted that in a West German scenario, these tonnage shortfalls might be alleviated by host nation support assets.

[46]Department of the Army, Field Manual 63-2-2: Combat Service Support Operations -- Armored, Mechanized and Motorized Divisions (1985): p. 5-11; Department of the Army, Field Manual 63-3J: Combat Service Support Operations -- Corps (1985): pp. 5-24 to 5-27; Department of the Army, Field Manual 63-20: Forward Support Battalion -- Armored, Mechanized and Motorized Divisions (1985): p. 5-15; Department of the Army, Field Manual 63-21: Main Support Battalion -- Armored, Mechanized and Motorized Divisions (1986): p. 5-6. An example of a specially designed tactical vehicle that hauls ammunition is the Heavy Expanded Mobility Transport Truck (HEMTT).

[47]Denis Bishop and W.J.K. Davies, Railways and War Since 1917 (1974): p. 2.

[48]Telephone Interview with Mr. George R. Hart, Chief, Training Management Division, United States Army Transportation School, Fort Eustis, Virginia, July 8, 1988.

[49]Bishop and Davies, op. cit., pp. 3, 5.

[50]Van Fleet, op. cit., p. 47; Albin G. Wheeler, "Operational Logistics in Support of the Deep Attack", Military Review (February 1986): p. 18.

[51]Bishop and Davies, op. cit., pp. 120, 121.

[72]Ibid., pp. 121, 126; Department of the Army, Field Manual 55-20: Army Rail Transport Units and Operations (1986): pp. 3-2 to 3-6.

[73]Bishop and Davies, op. cit., pp. 119, 120; Ziel, op. cit., p. 128.

[74]Department of the Army, Field Manual 100-5: Operations (1986): pp. 2, 3.

[75]Department of the Army, Field Manual 55-20: Army Rail Transport Units and Operations (1986): pp. 7-8, 7-9.

[76]The main vehicle supply route to Verdun was called "la Voie Sacree", or "the Sacred Way", because of the large number of deaths, vehicle losses and continual roadway repairs attributed to heavy German shelling. Almost as many men were killed due to nonbattle accidents on the "la Voie Sacree" as were due to losses from enemy interdiction operations. It is ironic that "la Voie Sacree" is still famous in Western Europe. Motor transport did not deliver as much cargo to the Verdun front as did the railroads. Even though rail accomplished this at considerably less cost in human life, its role is virtually ignored in most history books. Bishop and Davies, op. cit., p. 93; Denis Girard, The New Cassell's French Dictionary (1973): pp. 664, 757.

[77]Van Fleet, op. cit., p. 22.

[78]Department of the Army, Field Manual 100-5: Operations (1986): pp. 59, 60; Telephone Interview with Mr. George R. Hart, Chief, Training Management Division, United States Army Transportation School, Fort Eustis, Virginia, July 8, 1988.

[79]Telephone Interview with Major John W. Harris, Movement Control Plans Officer, Full-Time Manning Staff, 143rd Transportation Command, Orlando, Florida, October 31, 1988.

[80]Department of the Army, Field Manual 55-20: Army Rail Transport Units and Operations (1986): pp. 1-6 to 1-8.

[81]The 143rd TRANSCOM headquarters includes as part of its staff 13 rail officers and enlisted personnel to perform staff supervision and planning for railway operations. Telephone Interview with Major John W. Harris, Movement Control Plans Officer, Full-Time Manning Staff, 143rd Transportation Command, Orlando, Florida, October 31, 1988; Telephone Interview with Lieutenant Colonel Michael J. Swart, Senior Rail Staff Officer, 143rd Transportation Command, Orlando, Florida, January 10, 1989.

[42]Telephone Interview with Captain John R. Murphy, Assistant Intelligence (S-2)/Operations (S-3) Officer, Full-Time Manning Staff, 416th Railway Battalion, Jacksonville, Florida, October 31, 1988. The 416th Railway Battalion is in the process of converting to a new modified table of organization and equipment (MTOE). Department of the Army has approved the 416th's request to reorganize under MTOE 55-226, but at cadre strength. (During mobilization, this MTOE would authorize the the 416th to expand to the size of a normal railway battalion, such as the 757th.) Even though this is a step in the right direction, only small increases in peacetime personnel authorizations are anticipated. Problems are still likely to occur during mobilization in finding qualified men and women to fill empty billets. Telephone Interview with Lieutenant Colonel Michael J. Swart, Senior Rail Staff Officer, 143rd Transportation Command, Orlando, Florida, January 10, 1989.

[43]Department of the Army, Field Manual 55-20: Army Rail Transport Units and Operations (1986): pp. 1-14 to 1-25.

[44]Telephone Interview with Major Jeffrey M. Schroeder, Executive Officer, 757th Railway Battalion, West Allis, Wisconsin, October 31, 1988. The one engineering company performs maintenance of way on track, bridges, buildings and structures for a standard rail division which is 90 to 150 miles in length. The two equipment maintenance companies inspect, service and repair diesel-electric locomotives and rolling stock. Maintenance capabilities per company include the daily repairs for 80 railcars and 40 engines. The train operating company can provide yard and main line service, and perform switching functions for a rail division. It can muster 50 crews daily for yard and road duty. Department of the Army, Field Manual 55-20: Army Rail Transport Units and Operations (1986): pp. 1-18, 1-21, 1-23.

[45]Department of the Army, Field Manual 55-20: Army Rail Transport Units and Operations (1986): pp. 1-1, 1-14. The 757th Railway Battalion was reactivated in 1985 as a railway equipment maintenance battalion. In October 1987, it was reorganized as a railway battalion. Telephone Interview with Major Jeffrey M. Schroeder, Executive Officer, 757th Railway Battalion, West Allis, Wisconsin, October 31, 1988.

[46]Department of the Army, Field Manual 55-20: Army Rail Transport Units and Operations (1986): pp. 1-15, 8-5. The estimate for dry cargo was already calculated in Field Manual 55-20. A petroleum estimate is derived by using the most conservative tank car capacity of 6,000 gallons. This turns out to be a narrow gauge, foreign service tanker. The math calculation is as follows: 6,000 gallons x 20 tankers in the train = 120,000 gallons total.

[87]Math calculations are as follows: for dry cargo moving over a single main line, ten trains x 400 STONs per trainload = 4,000 STONs per day in one direction. For petroleum moving over a single line, ten trains x 120,000 gallons per trainload = 1,200,000 gallons per day in one direction. For dry cargo moving over a double main line, 15 trains x 400 STONs per trainload = 6,000 STONs per day in one direction. For petroleum moving over a double line, 15 trains x 120,000 gallons per trainload = 1,800,000 gallons per day in one direction.

[88]Department of the Army, Field Manual 101-10-1/2: Staff Officers' Field Manual -- Organizational, Technical and Logistical Data Planning Factors (Volume 2) (1987): p. 3-41. Math calculations are as follows: for dry cargo moving over a single main line, ten trains x 500 STONs per trainload = 5,000 STONs per day in one direction. For dry cargo moving over a double main line, 15 trains x 500 STONs per trainload = 7,500 STONs per day in one direction. No petroleum estimates are provided in Field Manual 100-10-1/2.

[89]The 16 percent figure is derived by dividing the daily rail capability of 6,000 STONs (Field Manual 55-20) by the 36,708 STONs required by the notional corps (Appendix J). The 20 percent figure is derived by dividing the daily rail capability of 7,500 STONs (Field Manual 101-10-1/2) by the 36,708 STONs required by the notional corps (Appendix J). The 61 percent figure is derived by dividing the daily rail capability of 1,800,000 gallons (Field Manual 55-20) by the 2,935,000 gallons required by the notional corps (Appendix C).

[90]United States Army Transportation School, Transportation Master Plan -- Coordination Draft (1987): p. 9-4.

[91]Another challenge concerns the nondeployable status of some of the 757th's operating equipment. The battalion will be restricted to using the locomotives, rolling stock and repair equipment currently in theater. Its own yard engines, railcars, tampers and other maintenance of way machinery must stay at home station -- those items are listed on a table of distribution and allowance (TDA). (Some of the 757's major end items are deployable, however, and are listed on their table of organization and equipment (TOE). The standard Army Corps of Engineer equipment -- dozers, five ton dump trucks, etc. -- fit this category.) Because our crews are likely to be unfamiliar with the foreign equipment, this will pose some difficulty and delays. That will necessitate some on the job training before Army railroaders can effectively operate. The consequences of such a delay in service to forward units are difficult to assess in advance. Telephone Interview with

Major Jeffrey M. Schroeder, Executive Officer, 757th Railway Battalion, West Allis, Wisconsin, October 31, 1988.

[42]Telephone Interview with Major Jeffrey M. Schroeder, Executive Officer, 757th Railway Battalion, West Allis, Wisconsin, October 31, 1988. The status of (railroad) military occupational specialties (MOSs) is so poor today that a finding in the Transportation Master Plan -- Coordination Draft states, "the lack of Army MOS training in rail related specialties for the few remaining Reserve units severely limits the Army's capability in rail as a transportation mode". United States Army Transportation School, op. cit., p. 9-2.

[43]The 1205th Railway Services Unit will fall under the control of Military Traffic Management Command in wartime. The unit will remain at its mobilization station -- Sunny Point -- which is the Defense Department's only multi-military service ammunition port on the east coast of the United States. The 1205th has approximately one-half the capability of the 757th. The former can muster 23 train crews and three, 13 man maintenance of way gangs. Telephone Interview with Major Robert W. McGuire, Jr., Executive Officer, 1205th Railway Services Unit, Middletown, Connecticut, October 31, 1988.

[44]Telephone Interview with First Lieutenant Mark A. Smith, Rail Operations Officer, 171st Movement Control Detachment, Yermo, California, October 31, 1988.

[45]Lewis I. Jeffries, "The Importance of Military Railways in Future Conflicts" (1975): pp. 9, 11.

[46]Department of the Army, Field Manual 55-20: Army Rail Transport Units and Operations (1986): p. 1-2.

[47]Department of the Army, Field Manual 55-20: Army Rail Transport Units and Operations (1986): p. 1-2; Lewis I. Jeffries, "The Importance of Military Railways in Future Conflicts" (1975): pp. 9, 11. Although not specified in Field Manual 55-20, host nation rail support should be considered a separate phase of rail operations. With host nation support, the U.S. Army is a customer of the foreign rail system and does not exercise any control over its operation. Telephone Interview with Lieutenant Colonel Michael J. Swart, Senior Rail Staff Officer, 143rd Transportation Command, Orlando, Florida, January 10, 1989.

[48]Albin G. Wheeler, "Operational Logistics in Support of the Deep Attack", Military Review (February 1986): pp. 16, 18.

[99]Personal Interview with Colonel Lewis I. Jeffries, Director of Academic Operations, Command and General Staff College, Fort Leavenworth, Kansas, July 8, 1988.

[100]The 757th Railway Battalion and 1205th Railway Services Unit are authorized to conduct supervised on the job training (SOJT) with unit personnel in charge of the programs of instruction. It is possible to qualify junior enlisted service members (grades E1 to E4) in their military occupational specialties, at night or on weekends, within a 12 month period. And this can be accomplished at home station. But the more senior enlisted soldiers still have to attend schools elsewhere on full-time active duty status. If United States Army Reserve Forces Schools could obtain qualified instructors, this might prove to be an excellent, alternate method of teaching rail courses and qualifying enlisted personnel. Telephone Interview with Major Robert W. McGuire, Jr., Executive Officer, 1205th Railway Services Unit, Middletown, Connecticut, October 31, 1988.

[101]The Research and Locomotive Evaluator/Simulator (RALES) was designed originally by the IIT Research Institute. The RALES system is the most realistic thing, next to actual road work, in training locomotive engineers. The system is constructed around a full-sized cab that is mounted on six axles and uses synchronized film projection onto cab windows to provide the sensation of movement. "Government News: Simulators Train Army Engineers", Defense Transportation Journal (October 1988): p. 76.

[102]Telephone Interview with Major Jeffrey M. Schroeder, Executive Officer, 757th Railway Battalion, West Allis, Wisconsin, October 31, 1988.

APPENDIXES

Notes on Appendixes

1. Annexes A through R are based on the "Notional Corps Laydown" study completed by the U.S. Army Logistics Center at Fort Lee, Virginia in September 1987. The Center made an extensive effort to develop realistic planning factors based on a notional corps composed of the following units:

a. Combat units include: a light infantry division, an armored division, two mechanized divisions, a standard National Guard infantry division, a separate light infantry brigade, an armored cavalry regiment, a separate armored brigade and a separate mechanized brigade.

b. Combat support units include: corps artillery (six field artillery brigades), a corps engineer brigade, a chemical group, a military intelligence group, a military police group, a signal group, a civil affairs brigade, a psychological operations battalion, an air defense artillery brigade and a corps aviation brigade.

c. Combat service support units include: a personnel and administration group, a finance group, a transportation brigade, an ordnance group, an explosive ordnance disposal group, a separate aviation maintenance battalion, a medical brigade, a materiel management center, a movement control center, a staff judge advocate, a chaplain and four support groups.

2. Daily consumption rates are based upon the first 30 days of a mid-intensity conflict in Western Europe.

3. It is assumed that class VI items will not be available until after the first 60 days of conflict.

4. Definitions of supply classes used in the appendixes are provided below. (Department of the Army, Field Manual 101-10-1/2: Staff Officers' Field Manual -- Organizational, Technical and Logistical Data Planning Factors (Volume 2) (1987): p. 2-2.)

a. Class I: Subsistence, including gratuitous health and welfare items.

b. Class II: Clothing, individual equipment, tentage, tool sets and tool kits, handtools and administrative/housekeeping supplies and equipment. Includes items of equipment (other than principal items) prescribed in authorization/allowance tables and items of supply (not including repair parts).

c. Class III: Petroleum, oil and lubricants (POL) -- to include class III bulk and class III package. Petroleum fuels: lubricants, hydraulic and insulating oils, preservatives, liquid and compressed gases, chemical products, coolants, deicing and antifreeze compounds, together with components and additives of such products and coal.

d. Class IV: Construction materials including installed equipment and all fortification/barrier materials.

e. Class V: Ammunition of all types (including chemical, radiological and special weapons), bombs, explosives, land mines, fuzes, detonators, pyrotechnics, missiles, rockets, propellants and other associated items.

f. Class VI: Personal demand items (nonmilitary sales items).

g. Class VII: Major end items. A final combination of end products which is ready for its intended use; e.g., launchers, tanks, mobile machine shops and vehicles.

h. Class VIII: Medical material including medical-peculiar repair parts.

i. Class IX: Repair parts and components including kits, assemblies, subassemblies and repairable/nonrepairable items required for maintenance support of all equipment.

j. Class X: Materiel to support nonmilitary programs; e.g., agricultural and economic development materials not included in classes I through IX.

5. The statement of purpose in the final report explains "the factors and rates used to develop these data are the latest Department of the Army approved consumption rates. They are based on theater averaged consumption rates developed in the course of studies conducted by various logistics proponents, and the Warramp methodology employed by the U.S. Army Concepts Analysis Agency in support of the Total Army Analysis process".

Appendix A

Notional Corps Transportation Capabilities

The notional corps has one transportation motor transport (TMT) group composed of three TMT battalions. These battalions include companies that are listed below.

Unit	Number	Line Haul Capability Per Company	Total Capability By Type Co
Command Transport Company	1	0	0
Cargo Transfer Company	2	0	0
Light-Med Truck Co	5	660 STONs daily	3300 STONs daily
Medium Truck Co (Cnr/Cgo)	6	2250 STONs daily	13500 STONs daily
Heavy Truck Company	1	36 tracked veh or 1440 STONs daily	1440 STONs daily
Medium Truck Co (5000 gal tankers)	2	450000 gals daily	900000 gals daily
Total Daily Capabilities			18240 STONs and 900000 gals

Notes:

1. Total tonnage transport capability for the corps TMT group is 18,240 STONs per day.

2. Total gallon transport capability for the corps TMT group is 900,000 gallons per day.

3. Line haul calculations are based upon two round trips per day, with a radius of 40 to 100 kilometers for each trip. Seventy-five percent vehicle availability is assumed.

4. The notional corps has two petroleum supply companies which can receive, store and issue bulk petroleum. Neither of them, however, has any local or line haul capability.

5. A petroleum pipeline and terminal operating company is normally assigned to theater army. This company can operate 100 kilometers of pipeline which, depending on units locations within the theater, could ease petroleum shortages within the notional corps.

6. Unit capabilities were extracted from the G-4 Battle Book, U.S. Army Command and General Staff College, Fort Leavenworth, Kansas, June 1, 1988.

Appendix B

Transportation Capabilities of Divisions, Separate Brigades and ACR Comprising the National Corps

	Dry Cargo Tonnage Lift (STONs per day)	POL Distribution Capabilities (gals per day)
Lt Inf Div S&T Bn	870	[illegible]
Arm Div S&S Co		[illegible]
Arm Div TMT Co	975	
Mech Div S&S Co		[illegible]
Mech Div TMT Co	975	
Mech Div S&S Co		[illegible]
Mech Div TMT Co	975	
Inf Div S&S Co		[illegible]
Inf Div TMT Co	1835	
Sep Lt Inf Bde Maint & Supply Co	226	[illegible]
ACR S&T Troop	445	[illegible]
Sep Arm Bde S&T Co	180	[illegible]
Sep Mech Bde S&T Co	180	71250
Total Daily Capabilities	6761	[illegible]

Notes:

1. Unit capabilities for the support elements of an armored division, two mechanized divisions, an armored cavalry regiment, a separate armored brigade and a separate mechanized brigade were extracted from the G-4 Battle Book, U.S. Army Command and General Staff College, Fort Leavenworth, Kansas, June 1, 1988.

2. Unit capabilities for the support elements of a light infantry division, a standard National Guard infantry division and a separate light infantry brigade were provided by Major James E. Myers, Deputy, Logistics Assessment Task Group, United States Army Logistics Center, Fort Lee, Virginia.

3. Lift capabilities for dry cargo and petroleum are based upon division base assets (i.e., those divisional units doctrinally found in division support areas and in the case of separate brigades, those units found in brigade support areas).

4. Line haul calculations are based upon two round trips per day, with a radius of 40 to 100 kilometers for each trip. Seventy-five percent vehicle availability is assumed.

5. The most current tables of distribution and allowance (TOEs) were used. This explains why a separate light infantry brigade (that operates with the older "H" series TOE) has a greater petroleum distribution capability than a light infantry division (that has already transitioned to the newer "L" series TOE).

Appendix C

Notional Corps Class III Bulk Requirements

Type Petro	Intense Combat	Moderate Combat	Light Combat	Reserve
(daily requirements in 000's of pounds)				
Mogas	3223	2288	1386	677
JP4	2887	2050	1242	606
Diesel	13801	9799	5934	2898
Total Lbs	19911	14137	8562	4181
(daily requirements in 000's of gallons)				
Mogas	520	369	223	109
JP4	453	322	195	95
Diesel	1962	1393	844	412
Total Gals	2935	2084	1262	616

Notes:

1. Conversion factors from pounds to gallons are as follows:

6.203 pounds = one gallon of mogas
6.375 pounds = one gallon of JP4
7.034 pounds = one gallon of diesel

Source: Department of the Army, Field Manual 10-69: Petroleum Supply Point Equipment and Operations (1986): p. E-1.

Appendix D

Mogas Summaries for Divisions, Separate Brigades and ACR Comprising the Notional Corps

(daily requirements in pounds)

	Intense Combat	Moderate Combat	Light Combat	Reserve
Lt Inf Div	127922	90824	55006	26864
Armored Div	261857	185918	112598	54990
Mech Div	243042	172560	104508	51039
Mech Div	243042	172560	104508	51039
Inf Div	199233	141455	85670	41839
Sep Inf Bde	50426	35802	21683	10589
Arm Cav Reg	78179	55507	33617	16418
Sep Arm Bde	55435	39359	23837	11641
Sep Mech	58994	41886	25367	12389
Total Lbs	1318130	935871	566794	276808

Appendix E

JP4 Summaries for Divisions, Separate Brigades and ACR Comprising the Notional Corps

(daily requirements in pounds)

	Intense Combat	Moderate Combat	Light Combat	Reserve
Lt Inf Div	226682	160944	97473	47603
Armored Div	274494	194890	118032	57644
Mech Div	254987	181041	109644	53547
Mech Div	254987	181041	109644	53547
Inf Div	45070	32000	19380	9465
Sep Inf Bde	13453	9552	5785	2825
Arm Cav Reg	149017	105802	64077	31294
Sep Arm Bde	0	0	0	0
Sep Mech Bde	0	0	0	0
Total Lbs	1218690	865270	524035	255925

Appendix F

Diesel Summaries for Divisions, Separate Brigades and ACR Comprising the Notional Corps

(daily requirements in pounds)

	Intense Combat	Moderate Combat	Light Combat	Reserve
Lt Inf Div	181089	128573	77868	38029
Armored Div	1915463	1359979	823649	402247
Mech Div	1894648	1345200	814699	397876
Mech Div	1925404	1367037	827924	404335
Inf Div	764654	542904	328801	160577
Sep Inf Bde	140606	99831	60461	29527
Arm Cav Reg	578021	410395	248549	121384
Sep Arm Bde	411026	291828	176741	86315
Sep Mech Bde	414571	294346	178266	87060
Total Lbs	8225482	5840093	3536958	1727350

Appendix G

Class III Bulk Requirements for
Divisions, Separate Brigades and ACR
Comprising the Notional Corps

Type Petro	Intense Combat	Moderate Combat	Light Combat	Reserve
	(daily requirements in 000's of pounds)			
Mogas	1318	936	567	277
JP4	1219	865	524	256
Diesel	8226	5840	3537	1727
Total Lbs	10763	7641	4628	2260
	(daily requirements in 000's of gallons)			
Mogas	213	151	91	45
JP4	191	136	82	40
Diesel	1170	830	503	246
Total Gals	1574	1117	676	331

Notes:

1. Conversion factors from pounds to gallons are as follows:

6.203 pounds = one gallon of mogas
6.375 pounds = one gallon of JP4
7.034 pounds = one gallon of diesel

Source: Department of the Army, Field Manual 10-69: Petroleum Supply Point Equipment and Operations (1986): p. E-1.

Appendix H

Notional Corps Personnel Authorizations

Light Infantry Division	10,596
Armored Div (6 M1A1, 4 M2, 2 AHB)	16,888
Mech Div (5 M1A1, 5 M2, 2 AHB)	16,976
Mech Div (4 M1, 1 M1A1, 5 M2, 2 AHB)	16,936
NG Inf Div (2 M60A3, 1 M113, 2 AHB-64)	14,737
Separate Light Infantry Brigade	4,150
Armored Cavalry Regiment (ACR)	4,802
Separate Armor Brigade	4,153
Separate Mech Bde (1 M60, 2 M113)	4,470
Total Personnel for the Divisions, Separate Brigades and the ACR	93,708
Notional Corps Total Personnel	179,986
Div, Sep Bde, ACR Personnel	(93,708)
Notional Corps Troops	86,278

Appendix I

Consumption Planning Factors

(lbs/man/day)

Supply Class	Intense Combat	Moderate Combat	Light Combat	Reserve
I	7.06	7.06	7.06	7.06
II	3.67	3.67	3.67	3.67
IIIp	.83	.59	.36	.17
IV	8.50	8.50	8.50	8.50
VIII	1.22	1.22	1.22	1.22

Notes:

1. The "Notional Corps Laydown" study provided the above consumption planning factors.

2. The study also calculated the tonnages for class V (Appendixes K and L), class VII (Appendixes M and N) and class IX (Appendixes O and P). It also estimated the gallons of class III bulk the notional corps would consume (Appendixes C through G).

Appendix J

Notional Corps Tonnage Requirements

(daily requirements in 000's of pounds)

The tonnage requirements provided below include all classes of supply except class III bulk.

Class	Intense Combat	Moderate Combat	Light Combat	Reserve
I	1271	1271	1271	1271
II	661	661	661	661
IIIp	149	106	65	31
IV	1530	1530	1530	1530
VII Appendix N	24510	17402	10539	5147
VIII	220	220	220	220
IX Appendix P	1001	667	501	140
Sub-Total (in 000's of Lbs, without Class V)	29342	21857	14787	9000
V Appendix L	44073	31292	18951	9255
Total Pounds (in 000's)	73415	53149	33738	18255
Total STONs (with Class V)	36708	26575	16869	9128

Notes:

1. Notional corps tonnage requirements for classes I, II, IIIp, IV, and VIII were calculated by multiplying personnel authorizations (Appendix H) by consumption planning factors (Appendix I).

2. Calculations for classes V, VII and IX are found in Appendixes L, N and P, respectively.

Appendix K

Class V Ammunition Summaries for Divisions, Separate Brigades and ACR Comprising the Notional Corps

(daily requirements in pounds)

	Intense Combat	Moderate Combat	Light Combat	Reserve
Lt Inf Div	2139992	1519394	920196	449398
Armored Div	5218217	3704934	2243833	1095825
Mech Div	5163354	3665981	2220242	1084304
Mech Div	4862749	3452551	2090982	1021177
Inf Div	3582301	2543433	1540389	752283
Sep Inf Bde	715899	508288	307837	150339
Arm Cav Reg	1220513	866564	524821	256308
Sep Arm Bde	1373405	975118	590564	288415
Sep Mech Bde	1264405	897727	543694	265525
Total Lbs	25540835	18133990	10982558	5363574

Appendix L

Class V Ammunition Summaries for the Notional Corps

(daily requirements in 000's of pounds)

	Intense Combat	Moderate Combat	Light Combat	Reserve
Corps Totals	44073	31292	18951	9255
Div, Sep Bde, ACR Totals (Appendix K)	(25541)	(18134)	(10983)	(5364)
Corps Troops Totals	18532	13158	7968	3891

Appendix M

Class VII Major End Item Summaries for Divisions, Separate Brigades and ACR Comprising the Notional Corps

(daily requirements in pounds)

	Intense Combat	Moderate Combat	Light Combat	Reserve
Lt Inf Div	370072	262751	159131	77715
Armored Div	3205280	2275749	1378271	673109
Mech Div	3077804	2185241	1323456	646339
Mech Div	2776328	1971193	1193821	583029
Inf Div	2460556	1746995	1058039	516717
Sep Inf Bde	282587	200637	121513	59343
Arm Cav Reg	803297	570341	345418	168692
Sep Arm Bde	1801837	1279304	774790	378386
Sep Mech Bde	1326000	941460	570180	278460
Total Lbs	16103761	11433671	6924619	3381790

Appendix N

Class VII Major End Item Summaries for the National Corps

(Daily requirements in tons of pounds)

	Intense Combat	Moderate Combat	Light Combat	Reserve
Corps Totals	2451	1742	1579	547
Div, Sep Bde, ACR Totals	16 4	11474	(6925)	(7782)

Append: M

Corps Troops Totals	8405	5988	3614	1765

Appendix Q

Class IX Repair Part Summaries for Divisions, Separate Brigades and ACR Comprising the Notional Corps

(daily requirements in pounds)

	Intense Combat	Moderate Combat	Light Combat	Reserve
Lt Inf Div	15788	10596	7917	2217
Armored Div	168589	112365	84295	23603
Mech Div	162410	108246	81205	22737
Mech Div	162471	108287	81236	22746
Inf Div	72516	48332	36258	10152
Sep Inf Bde	8887	5923	4443	1244
Arm Cav Reg	52587	35049	26293	7362
Sep Arm Bde	41639	27752	20819	5829
Sep Mech Bde	38538	25686	19269	5395
Total Lbs	723425	482236	361735	101285

Appendix P

Class IX Repair Part Summaries for the Notional Corps

(daily requirements in 000's of pounds)

	Intense Combat	Moderate Combat	Light Combat	Reserve
Corps Totals	1001	667	501	140
Div, Sep Bde, ACR Totals (Appendix O)	(723)	(482)	(362)	(101)
Corps Troops Totals	278	185	139	39

Appendix Q

Tonnage Requirements for Divisions, Separate Brigades and ACR Comprising the Notional Corps (Less Class III bulk)

(daily requirements in pounds)

Supply Class	Intense Combat	Moderate Combat	Light Combat	Reserve
I	661578	661578	661578	661578
II	343908	343908	343908	343908
IIIp	77778	55288	33735	15930
IV	796518	796518	796518	796518
VII Appendix M	16103761	11433671	6924619	3381790
VIII	114324	114324	114324	114324
IX Appendix O	723425	482236	361735	101285
Sub-Total (in Lbs, without Class V)	18821292	13887523	9236417	5415333
V Appendix K	25540835	18133990	10982558	5363574
Total Pounds (with Class V)	44362127	32021513	[illegible]18975	10778907
Sub-Total in STONs (without Class V)	9411	6944	4618	2708
Total STONs (with Class V)	22181	16011	10110	5390

Notes:

1. Class I, II, IIIp, IV, and VIII requirements for divisions, separate brigades and the ACR were calculated by multiplying personnel authorizations (Appendix H) by consumption planning factors (Appendix I).

2. Calculations for classes V, VII and IX are found in Appendixes K, M and O, respectively.

Appendix R

Separate Mechanized Brigade and Armored Division Tonnage Requirements

Supply Class	Moderate Combat	Intense Combat
Separate Mechanized Brigade Tonnage Requirements		
(daily requirements in pounds)		
I	31558	31558
II	16405	16405
IIIp	2637	3710
IV	37995	37995
V (Appendix K)	897727	1264405
VI	NA	NA
VII (Appendix M)	941460	1326000
VIII	5453	5453
IX (Appendix O)	25686	38538
Sub-Total	1958921	2724064
Armored Division Tonnage Requirements		
(daily requirements in pounds)		
I	119229	119229
II	61979	61979
IIIp	9964	14017
IV	143548	143548
V (Appendix K)	3704934	5218217
VI	NA	NA
VII (Appendix M)	2275749	3205280
VIII	20603	20603
IX (Appendix O)	112365	168589
Sub-Total	6448371	8951462
Grand Total in Lbs	8407292	11675526
Grand Total in STONs	4204	5838

Notes:

1. The 757th Railway Battalion can doctrinally transport 4000 STONs a day in one direction over single main line and 6000 STONs over a double line.

2. From the above calculations, the 757th Battalion has just enough capability to resupply an armored division and separate mechanized brigade, at moderate and intense levels of combat. This assumes lines of communication less than 150 miles in length and the availability of double track.

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